# GEOGRAPHIC SCHOOL BULLETINS

THE NATIONAL GEOGRAPHIC SOCIETY, WASHINGTON 6, D.C.

VOLUME XXXVI, NUMBER 9, DECEMBER 2, 1957 . . . *To Know This World, Its Life*


# OIL

***World-Wide Drama***

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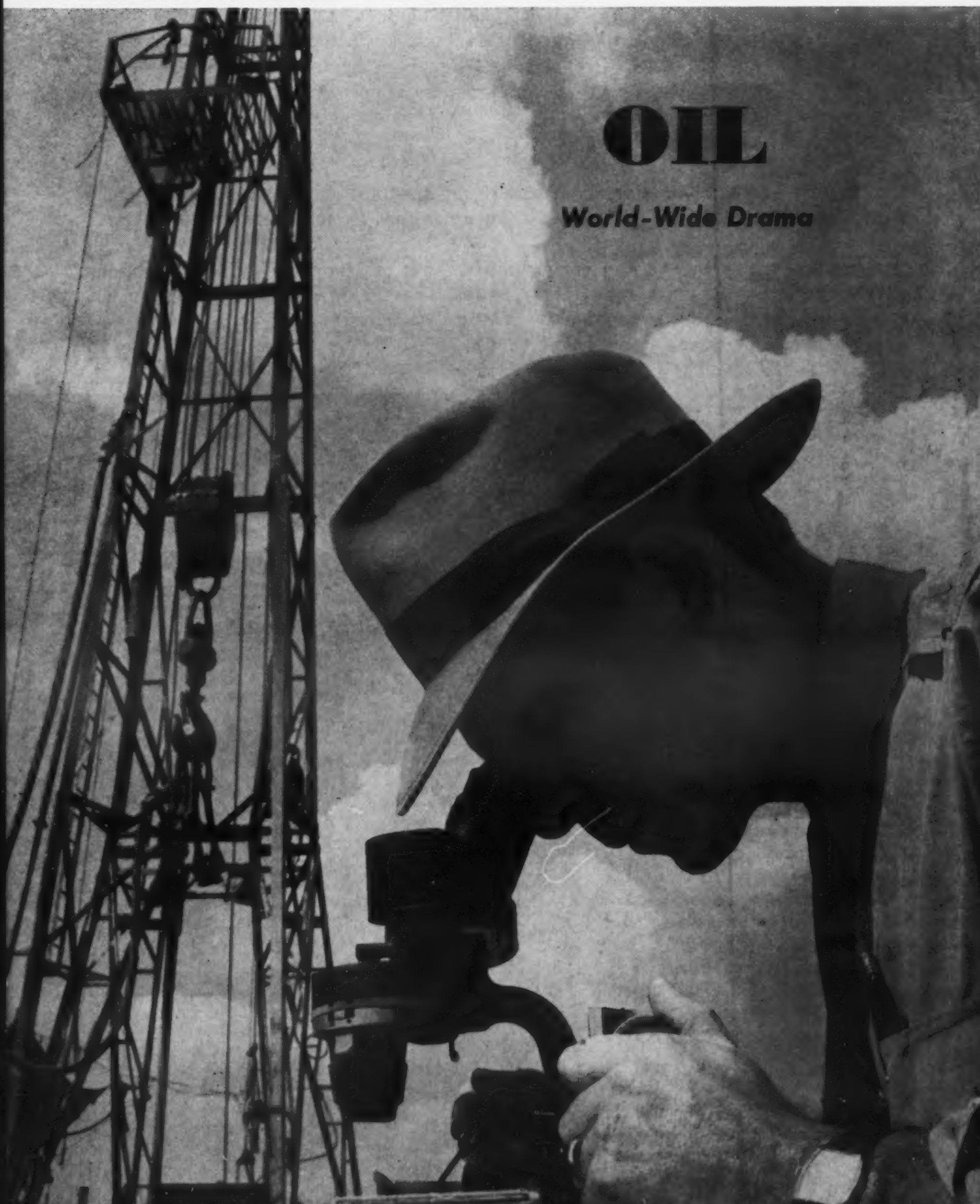

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upward by a fold or upheaval beneath it. Rising to the top of the arch, the oil may be awaiting the drill. A third likely formation is a stratigraphic trap, where two layers of dense rock come together, pinching the porous layer between them and holding its burden of oil.

To seek out these flaws, the oil explorer may start by studying the surface pattern of the land, seeking clues to its geology. Since different strata exert varying amounts of gravity and magnetism, he can record these differences with measuring devices—the gravity meter and the magnetometer.

His most spectacular method is by seismograph—the device that measures earthquakes. Crisscrossing a possible oil field, often by helicopter (above), geologists set off small depth charges buried underground. Shock waves from the explosions rebound from the various strata at different angles and of course take longer to bounce from a deep layer than a shallow one. These reverberations are picked up and recorded by geophones—the oil hunters call them "jugs." A graph of results shows pretty clearly where strata lie and at what angle.

The whole world is a laboratory for these oil searchers. They plunge through the forests of Canada and the jungles of South America. Their air-conditioned truck caravans thunder across the stillness of Arabia's Empty Quarter (GSB Nov. 11, 1957). They speak knowingly of Indonesia, New Guinea, and the nations of Europe. They range across the United States from California to New York State. Their explosives spout white geysers from the blue waters of the Gulf of Mexico. With surveying instruments, they work in bleak loneliness among the mountains of Wyoming (below).

After the oil hunters have tested the ground, the company moves in with a wildcat rig. In the brawling days of oil, a wildcatter was a free lance who gambled his borrowed shirt that he'd strike oil—and often lost it. Now the term applies to any exploratory rig. Big oil companies set up rank wildcat outfits to try to find new fields. They wouldn't risk the expense without the clues that science has furnished.

Even with all the aid geology provides, only about 11 percent of these wildcats hit oil. The rest fetch what drillers call "suitcase rock"—the dry dirt that prompts all hands to pack up and move to another location.

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**For countless centuries man has used oil found on the surface. The Bible mentions pitch. American Indians scooped up seepages for medicine. Seamen calked their ships with scummy tar on Lake Maracaibo. But only 98 years ago did man first drill for petroleum. In the short century since, the whole machinery of civilization has come to turn on oil. These pages show how men find, claim, and use this priceless gift of nature.**

# The Endless Search

*Oil hunters gather evidence of the depth and inclination of earth's various layers, then plot them with strings, left. As drills go down, scientists peer at cuttings brought to the surface, as the cover picture from Standard Oil Co. (N.J.) shows. Every handful helps answer the oilman's query, "Will we strike it here?"*

TO find the birth of oil go back perhaps 100,000,000 years. Billions of tiny organisms lie along the shore lines of strange seas that lap across today's continents. They feed on marine plants, rich in sun's energy. As the infant earth hunches its shoulders of land, water rushes in to swamp this marine life, to smother it in sediment.

After milleniums, marine sediments have formed oil and gas. No one knows exactly how. One theory suggests that bacterial action, combined with pressure, performed the magic.

The oil hunter enjoys a broad preserve. About a quarter of the earth's total land surface was once submerged and so could conceal oil-bearing rock. But just the presence of an oil-bearing layer doesn't mean that profitable quantities can be tapped. There must be an irregularity to trap the oil.

By plane and helicopter, on foot, even skin diving with an Aqua-Lung, the geologist looks for flaws in underground layers. If he can find a fault, where layers have slipped, he knows there's a good chance that porous, oil-bearing rock may be up against a stratum of dense rock. Its seepage blocked, oil may gather at the break.

Another possibility is an anticline, where the oil-bearing stratum is arched

BEAUMONT CHAMBER OF COMMERCE

startlingly different from today's drilling operation. Drake's well, above, in Titusville, Pennsylvania, was a crude wooden tower holding a bit like a battering ram. Raised and then dropped, the heavy implement smashed its way down 69½ feet while "Colonel" Drake (the title was bestowed to impress the local citizenry) kept shoring up his hole with pipe. At that remarkably shallow depth, the ram plowed into oil-bearing rock and the well started to flow at the rate of 15 to 20 barrels a day. Drake and his colleagues prided themselves on helping fill thousands of kerosene lamps. Actually, they had pioneered an industry that now shapes destinies of every nation.

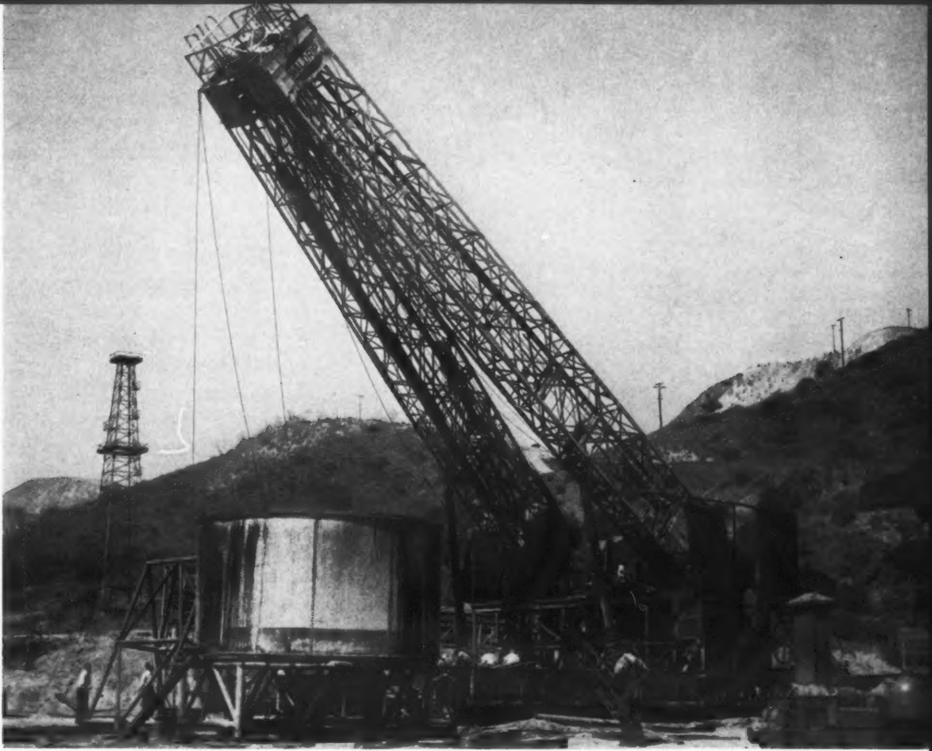
Many changes have affected oil production since those days. Every movie fan is familiar with the typical drama, usually laid in Texas, of bringing in a gusher. Certainly oil used to spout high in the air when a well came in as this historic photograph of the original Lucas Gusher in Texas shows. But any petroleum engineer who allowed such a thing to happen these days would be fired on the spot. Oil is a precious commodity, not to be blown all over the landscape.

To guard against gushers, the aptly-named Christmas Tree (right) now caps any oil well that has sufficient natural pressure to bring oil to the surface. This intricate collection of valves and blowout preventers regulates the flow of oil and shunts it into a pipeline or a storage tank.

Wells with less natural pressure require pumping. West-bound vacationists often notice rocker-arm pumps rhythmically nodding their heads like mechanical birds. These devices are drawing oil from a subterranean field.

Though the drama of spouting oil is obsolete, there is plenty of theatrical impact to the lively process of drilling, as the next pages indicate.

NATIONAL GEOGRAPHIC PHOTOGRAPHER B. ANTHONY STEWART



SHELL OIL COMPANY, INC.

# The Earth Is Tapped

GEOLOGISTS can only make a highly educated guess as to the likelihood of finding oil deposits. No one can know for sure until the churning bit gnaws its way into the earth's crust. Every factor is analyzed before the drill "spuds in."

The ponderous steel structure above is a portable electric drilling rig, one of the newest tools of a business that fashions new devices constantly. Trundled into place behind a truck, the 18-ton derrick is unfolded to its upright position—12 stories tall. It supports an eight-ton traveling block, or pulley, which is raised and lowered by heavy cable. Hooked to the block is a swivel that clutches the kelly, a flat-sided steel shaft. The kelly passes through the rotary table on the floor of the rig. This is where power is applied. The table whirls, gripping the flat sides of the kelly and spinning it. Coupled to a mile or so of drill pipe, the kelly imparts the spin right down to the hard-toothed bit.

When Edwin L. Drake brought in the first oil well in the United States in 1859, his methods were

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# The Rotary Drill

BUSINESS end of the oil rig is the gleaming bit, left. Rotary drilling, invented in the 1890's, reaches oil at fantastic depths. One hole goes down four miles. These gearlike teeth revolve, chewing rock somewhat like a pencil sharpener. Most bits are perforated to allow heavy, semiliquid mud to gush down the drill pipe and out through the churning teeth of the bit. The mud serves to lubricate the bit and also to wash away the cuttings. It flushes these up through the space

THOMAS HOLLYMAN (LEFT); ARABIAN AMERICAN OIL CO.

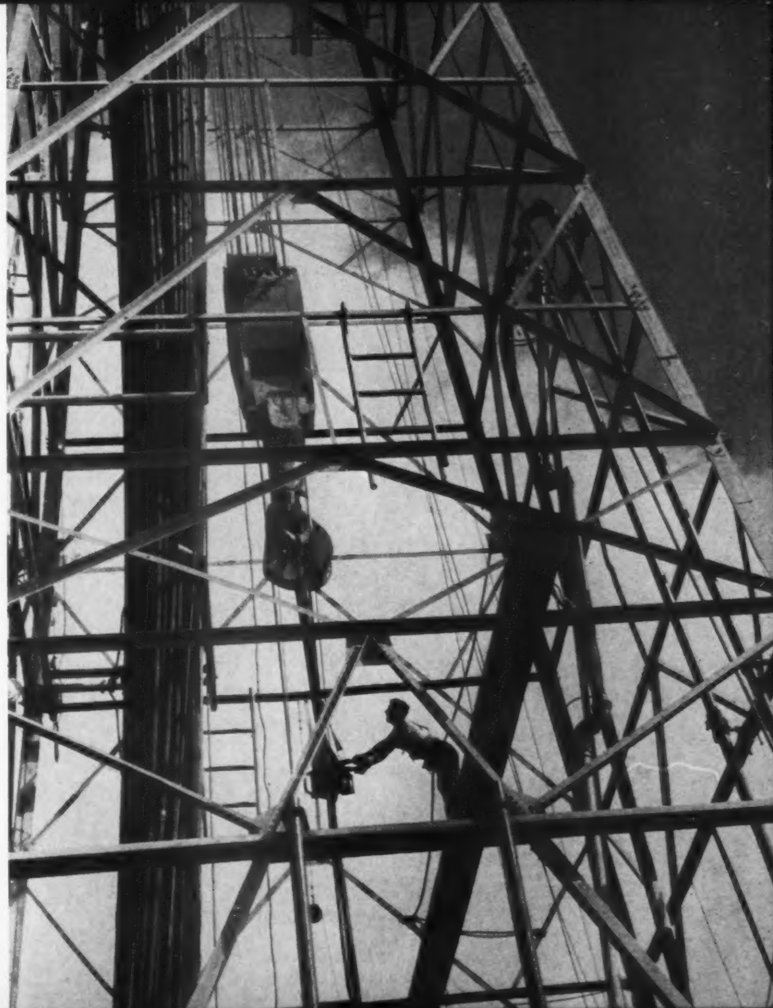
HAMILTON WRIGHT

The drilling crew is an international brotherhood. These Colombians (left) and Arabs (lower left) could be working on the same rig with the grinning American, for all do the same job the same way. When the bit grows dull they must "yo-yo" a mile or so of pipe out of the hole. They uncouple 90-foot lengths and a man high on the "monkey board" (right) racks each section against the side of the derrick. Then the bit is changed and the pipe painfully reassembled and returned to the depths.

between drill pipe and outer casing the same way you can make a full glass overflow by blowing into it through a straw.

When the bit finally gnaws into the oil-bearing layer, the work tempo increases. Slender tubing replaces the drill pipe. More outer casing is lowered to shore up the bottom of the hole.

Oil surges into the hole, but is met by the weight of the long column of mud. Thus it is held back while the drilling crew pumps water down the tubing to replace the mud. Men bolt the Christmas tree into place and open a valve. The water spurts back out, pushed upward by oil. . . . The gamble has paid. A well has come in.



EDWARDS PARK, NATIONAL GEOGRAPHIC STAFF

a level where the temperature has cooled enough to turn it back to liquid form. In droplets, it forms on the tray and is piped off.

Different kinds of oil condense at different temperatures. Thus oil that forms on the trays at 300 degrees F. is kerosene. At a lower level, oil is condensing at 500 degrees F. This is heating oil for home furnaces. Lower still, at hotter temperatures, lubricating oil is being caught and piped off. On the other hand, above the kerosene level, gasoline goes nearly to the top of the tower before it condenses. And gas, of course, doesn't condense at all, but is simply piped away from the crest of the fractionating unit.

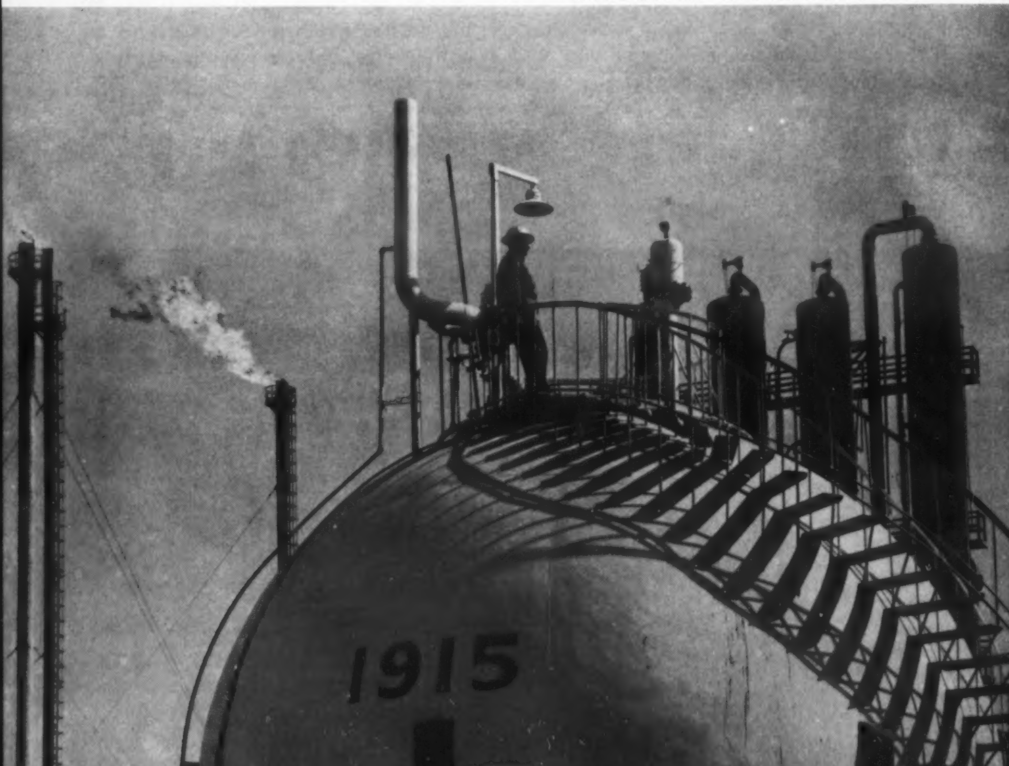
So the fractionating tower takes in hot crude oil and separates it into kerosene, heating oil, lubricating oil, and so on. Another refining device, the catalytic cracking unit, or "cat cracker," adds a chemical to the crude oil which actually breaks up heavy molecules to form lighter ones. Cracking allows far more gasoline to be separated from crude oil than can be recovered by distillation through the fractionating tower.

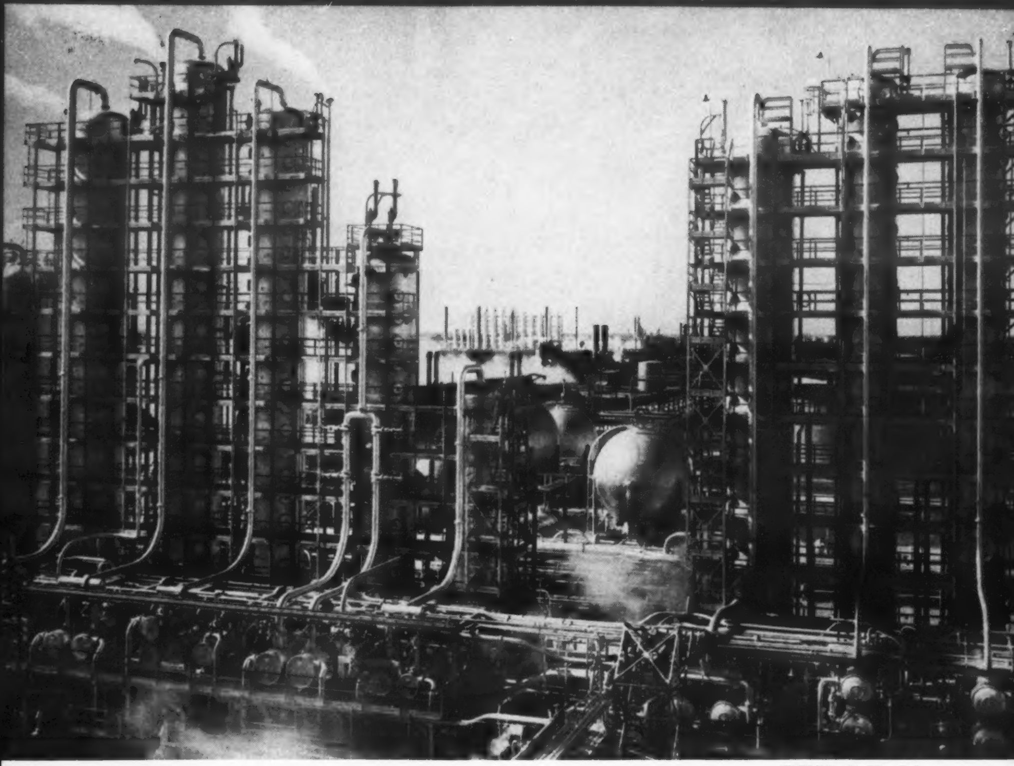
A refinery does more than make gasoline. Scientists can make big petroleum molecules by joining small ones, or rearrange the atoms in molecules, altering and reshaping oil in the process. Various oil products go through purifying stages. If a lubricating oil, for example, contains paraffin wax, engineers dilute it, then chill it. The wax congeals into flakes and is removed. The result is pure lubricating oil—and paraffin for homemade jam.

Many of the gases found in oil are fed into special tanks for use in manufacturing. Spherical tanks like the one below store gas under extreme pressure. This one holds isobutylene which will help make butyl rubber. Other gases released during the cat-cracking process, for example, are burned off. Their orange flames are familiar to anyone who has driven past a refinery.



NATIONAL GEOGRAPHIC PHOTOGRAPHER J. BAYLOR ROBERTS





STANDARD OIL CO., N.J.

# Products Are Born

TO list all the ways that people use oil would probably fill this issue of the GEOGRAPHIC SCHOOL BULLETINS from cover to cover. But remember that aside from turning wheels and lubricating them, oil enters millions of lives every day in the form of shampoos, vanishing and cold creams, furniture polish, detergents, wax paper, disinfectants, food containers, rouge, synthetic rubber, polish removers, plastics, drugs, and scores of other everyday items. All of them start in that bewildering city of towers, tanks, pipes, and cylinders (above) called a refinery.

Here crude oil is cooked, cooled, and mixed with chemicals. The purpose: to redesign the various crude oil molecules, all made up of hydrogen and carbon atoms, into different substances. The fractionating unit shown above separates the various parts of crude oil according to their weight. The oil is piped through a furnace that heats it under pressure. When it is released near the bottom of the fractionating tower, most of it expands into vapor.

The fractionating tower is divided by a number of horizontal trays with perforations. The vapor can pass through them, from one level to the next. But the coolness of the upper levels gradually condenses the vapor. In each layer, some oil dribbles down onto the tray.

Follow a certain component of oil through this process. Mixed with other components of various sizes and weights, it is heated to 800 degrees F. Pressure keeps it from boiling into a vapor. Then it enters the fractionating tower, pressure is released, and it vaporizes.

It floats upward through the perforations of tray after tray until it reaches

the gates of Jerusalem, which carried water to the pool of Siloam. Crude oil pipe diameters range from two to 30 inches. A 24-inch line can transport 18 times the load of an eight-inch line and six times that of a 12-inch line, the American Petroleum Institute points out.

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The first major pipeline was laid in 1879 from Coryville, in western Pennsylvania, across the Allegheny Mountains to Williamsport—110 miles away. It was a marvel—then. But technical advances soon left it out of date. Slugs of water separated different batches of products moving through the same line in the early industry days. Now, scientifically-regulated rates of flow and pressure maintenance prevent mixing. A dozen or more different batches share passage through the line in close succession. Pumping stations as far as 200 miles apart move oil at two or three miles an hour (see picture, next page). Airplanes patrol the lines, spotting leaks.

How long will oil hold out? Experts in the industry offer widely conflicting estimates. Some believe the United States will reach its peak of production in 1965, then go through a decline. They see 1985 as a production peak for the world as a whole. But production, though declining, should continue for centuries, they say.

It's hard to pin down the total proved oil reserves of the United States because the estimated figure keeps changing. Withdrawals of oil diminish proved reserves. But drilling leads to discoveries of new fields. Even old fields often prove larger than supposed. Proved reserves of United States oil in 1920 totaled 7.2 billion barrels. Nearly six times that quantity have been withdrawn since then. And many geologists believe that future discoveries will match those of the past.

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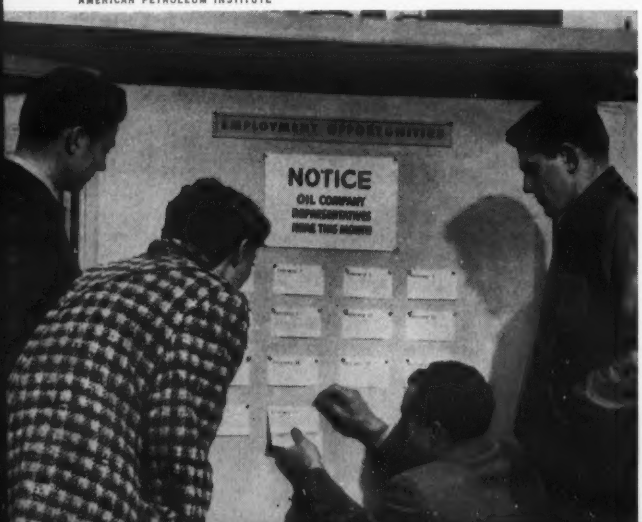


Offshore oil discoveries in the Gulf of Mexico have opened a rich new area for exploitation.

So there is no shortage—now. And the college boys, left, seem to face a bright and exciting future in the oil business. They'll have plenty of company. Nearly two out of every hundred Americans earn livelihoods from oil and its more than 2,000 by-products.

CITIES SERVICE CO.

# Oil Goes to Market

POUNDING along at some 18 knots, the 38,000-ton tanker *W. Alton Jones* can carry 336,000 barrels of oil to market. She is one of the new, big, fast tankers that have been slipping down the ways since World War II. Largest of all is the *Universe Leader,* 855 feet long—almost in a class with the *Queen Mary.*

These are the ships that carry oil around the world. When war threatens or a waterway such as the Suez Canal is closed and the ships arrive late, millions of people feel the effect.

Ships carry oil far from salt water. Besides the Great Lakes, the United States is threaded by nearly 29,000 miles of inland waterways, vastest system in the world, enabling barge and tanker to serve many large producing fields and refining centers. Some barges are self-propelled; others string along, eight or ten in a tow, each bearing upward of 20,000 to 30,000 barrels of oil. More than 1,000,000 barrels of petroleum and its by-products are transported daily on our inland waterways.

Familiar railroad tank cars owe their origin to the flat cars burdened with barrels of oil during the early 1860's. By 1865, two 40-to-50-barrel-capacity wooden tanks rode upright on flat cars. Then iron tanks of 90-barrel capacity were used. Next step was the familiar horizontal tank car. Today, general-purpose tank cars hauling crude oil and petroleum products use heating coils or insulation to guard against heat or cold. Special tank cars are built to withstand the pressure of compressed gases. Approximately 162,000 railroad and privately-owned tank cars of all kinds roll over the United States railroads.

Horse-drawn wagons used to creak through local areas in the early 1900's, carrying up to 1,500 gallons of oil. Thirty years later the bulk truck came into the picture and has grown to be such a familiar sight that few householders would be surprised at the picture below of *four* tank trucks delivering fuel oil at once.

Biggest of all oil carriers is the pipeline. More than 200,000 miles of it carry crude oil and refined products through 44 states and the District of Columbia.

This convenient method of transport is as ancient as the tube of stone outside

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## Like a Heart, the Pumping Station Circulates the Blood of Industry Through Steel Arteries

Having struggled to bring oil from the ground, men set about burying it again —in mighty pipes like this 12-inch line in Texas. Rising to the surface, oil passes through pumping stations where the flow is maintained and where certain consignments can be sidetracked and stored. In such places, and on fields where derricks rise at well-spaced intervals, oil changes the face of the countryside.

Oil's *unseen* impact is even greater. It has opened up lands that were almost unknown a few decades ago. Far from calming troubled waters, it has stirred international storms. Yet all nations hope oil will flow for another 100 years.